chapter 7

STRATEGIC PROCESS STUDIES AND REGIONAL MONITORING

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INTRODUCTION

The Orange County Sanitation District (District) operates under the auspices of a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the United States Environmental Protection Agency and the State of California Regional Water Quality Control Board (Order No. R8-2012-0035, NPDES Permit No. CA0110604) in July 2012. The permit requires the District to conduct an ocean monitoring program (OMP) that documents the effectiveness of the District's source control and wastewater treatment operations in protecting coastal ocean resources and beneficial uses. Part of the codified OMP is a requirement to conduct Strategic Process Studies (SPS) and to participate in regional monitoring programs. In addition, the District performs special studies, which are generally less involved than SPS and have no regulatory requirement for prior approval or level of effort.

SPS are designed to address unanswered questions raised by the core monitoring program results or they may focus on issues of interest to the District, such as the effect of contaminants of emerging concern on local fish populations. Some SPS are enumerated in the NPDES permit. Other SPS are proposed annually to, and must be approved by, state and/or federal regulators to ensure proper focus and level of effort.

Regional monitoring studies are those not focused solely on the District's monitoring area, but which focus on larger areas of the Southern California Bight. These may include the "Bight" studies coordinated by the Southern California Coastal Water Research Project (SCCWRP) or studies conducted in coordination with other public agencies and/or non-governmental organizations in the region. Examples include the Central Region Kelp Survey Consortium and the Central Bight Water Quality Study.

This chapter provides study overviews of recently completed and on-going SPS, special studies, and regional monitoring efforts. Unlike the other chapters in this report, these summaries are the most recent information available up to the publication of this report. In most cases, this information is also used in other chapters of this report to corroborate and supplement core monitoring results. This chapter provides study summaries only and the projects described are not intended as comprehensive reports. Final study reports are available in PDF format at www.ocsd.com.

STRATEGIC PROCESS STUDIES

Sediment Mapping

Maps are an extremely effective data summary tool used to demonstrate spatial extent and magnitude of environmental conditions. Maps help put information about contaminant gradients relative to a source(s) into context over the entire area of interest. Maps of environmental condition in the area of interest across multiple years may help identify changes in spatial extent (i.e., is the outfall footprint expanding or shrinking over time?). However, the ability to create maps with scientific rigor is difficult and rarely accomplished as sampling grids are often too sparse to capture the necessary spatial variability to make reliable predictions at un-sampled locations. The District publishes contour maps of pollutants and sediment physical parameters in the Marine Monitoring Annual Reports. These maps are based on the placement of existing sediment sampling stations prescribed in the NPDES discharge permit. This sampling scheme may not be optimal for accurately assessing the outfall footprint for contaminants discharged with the treated wastewater effluent or for assessing potential impacts to biological communities.

The objective of this study is to statistically determine the optimal sediment station array for accurate map generation of the District's outfall footprint for sediment geochemistry analytes and benthic infaunal community metrics. Improved maps will ultimately provide better data for the determination of NPDES permit compliance and empower managers, regulators, and other stakeholders with the best available information on spatial and temporal trends of sediment impacts from the wastewater discharge. As a result of this study, we will be able to answer the following questions: (1) How representative is our existing station grid of the outfall area? (2) Are we under-sampling some areas and/or over-sampling others? (3) What is the most cost-efficient grid spacing to provide accurate mapping contours? (4) How many additional stations are necessary to characterize spatial variance in the area around the discharge and/or other areas of influence (e.g., Santa Ana River); and (5) What analyses (e.g., chemical parameters, biological indices) will provide the best resolution for mapping the area?

This study is being conducted in two phases. Phase I, completed in March 2010, used District's historical benthic monitoring data to determine the appropriate chemical and biological measures to use in the analysis and to determine where data gaps exist. Spatial trends were assessed using variograms. Variograms model the spatial variability of the data which provides an estimate of optimal station intervals. This was used to focus additional field sampling conducted in Phase II. Phase II had two field sampling events to collect data where gaps exist and to refine the final optimized station location map. The first field sampling event was conducted in July 2011 and the second in July 2012. The analysis of the July 2012 infaunal samples was completed in December 2013. The finalization of the optimized station map is on track for completion by December 2014.

Changes In Biological Communities Near The OCSD Outfall

Beginning in 2006, the invertebrate community within the zone of initial dilution (ZID), the area within 60 m of the outfall pipe, began showing changes in community structure and community health index scores. The trend began slowly, but increased rapidly in 2008 through 2010. Changes included a decrease in the number of species and individuals at some stations coupled with increased abundances of pollution tolerant species (e.g., the polychaete *Capitella capitata*) and decreases in pollution sensitive species, such as amphipod crustaceans. These changes were localized to sites less than 1 km from the point of discharge (Figure 7-1) and there was a gradient away from the outfall suggesting the outfall as the source. No correlations between changes in biota and sediment geochemistry were found. It is likely that the causative factor(s) was something not measured as part of the core ocean monitoring program.

The District has undertaken three treatment process changes in the last 10 years that have altered effluent characteristics: 1) Effluent disinfection by chlorination with hypochlorite bleach followed by de-chlorination with sodium bisulfite began in August 2002, 2) the District went under a consent decree issued in 2002 to achieve secondary treatment standards by 2012 requiring significant construction and changes in treatment processes, and 3) the Ground Water Replenishment System (GWRS) water reclamation project was initiated in January 2008. The last project has decreased the average volume of effluent discharged into the ocean from 237 MGD in 2006-07 to 137 MGD in 2012-13. While the effluent volume has decreased, the mass balance of contaminants being discharged has not decreased to the same degree. Furthermore, the lower flow rate resulted in a decreased ejection velocity. This results in effluent particles settling closer to the outfall.

Staff addressed this issue with a two-phased approach (Table 7-1). The first was to use existing data on infaunal and fish communities and attempt to correlate changes over time with sediment geochemistry, final effluent, and treatment plant data. The second phase was to conduct focused studies targeting potential causes identified in the first phase. A total of 10 individual studies were completed in this investigation.

Results showed that the District's use of chlorine bleach for disinfection, daily maximum chlorine residual levels, and the final effluent flow rate were highly correlated with the observed effects on invertebrate communities. Outfall gradients (concentrations higher at the outfall that decrease with increased distance from the diffuser) were found for sediment and fish tissue concentrations of disinfection by-products, specifically trihalomethanes (THM) and haloacetic acids (HAA). Concentrations were higher in fish tissues than sediments indicating that bioaccumulation of these contaminants occurred. Laboratory studies found that these disinfection by-products are formed during the disinfection process. No whole effluent toxicity or sediment toxicity was found suggesting that the cause of the decline in invertebrate communities acts on a longer timescale than is measured in standard toxicity tests. This is consistent with the accumulation of disinfection by-products in sediments and tissues until a threshold concentration is reached. Histological examination of fish livers found that pathologies and abnormalities were more prevalent and greater in magnitude in fish collected near the outfall compared to the reference site.

Based on these results, staff concluded that the discharge of chlorinated effluent coupled with lower outfall effluent ejection velocity likely caused the decline in invertebrate communities near the outfall. In March 2011, the District achieved full secondary treatment on 100% of the effluent. In January 2012, there was some evidence of recovery in invertebrate communities near the outfall. This trend continued into the 2012-13 monitoring year. It is not known how long it will take to reach full recovery or if full recovery is even possible with continued effluent disinfection. An external expert panel is being convened to

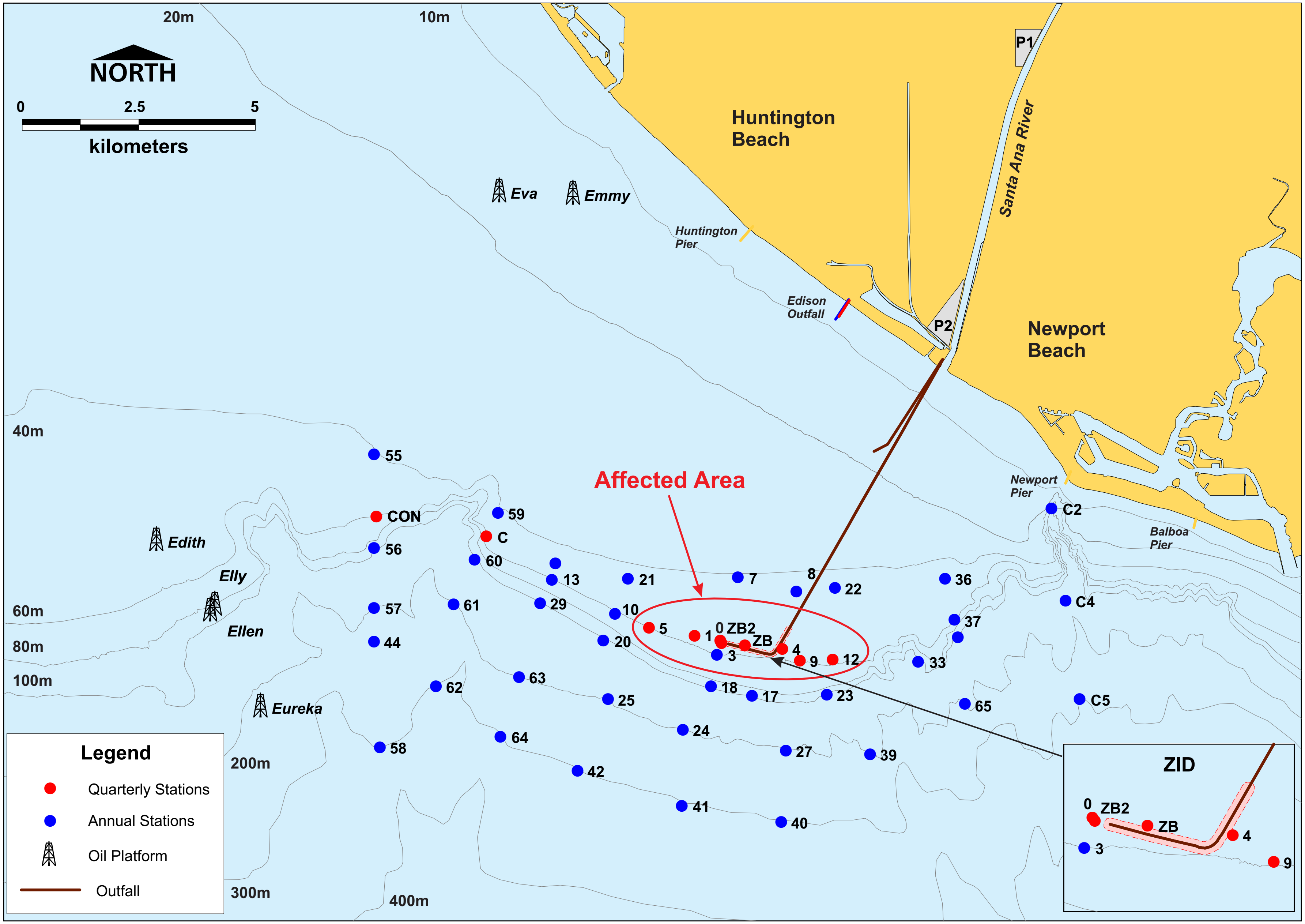

Figure 7-1. **Map of the District's monitoring area showing the zone of initial dilution (ZID) and the affected area experiencing decreased invertebrate community health.**

Orange County Sanitation District, California.

Table 7-1. ZID Investigation projects; Phase I: 2009-10, Phase II: 2011-12.

Orange County Sanitation District, California.

Project Title	Project Description	Project Status	Completion Date
Phase I: Historical Data Review and Literature Search			
Before-After-Control-Impact (BACI) Study	Use core monitoring data prior- and post-event (i.e., effluent chlorination, Ground Water Replenishment System) to statistically test for significant change in conditions.	Completed	April 2010
Review and Statistical Analysis of Treatment Plant and Ocean Monitoring Data	Review of historical treatment plant and ocean monitoring receiving water data; statistical analysis of data to determine if data relationships exist relative to observed benthic impacts.	Completed	June 2010
Literature Review	Review of the scientific literature for impacts to marine biota from the release of effluent chlorination by-products.	Completed	June 2010
Phase II: Targeted Studies			
Sediment Profile Imaging Near the Orange County Outfall	Visual assessment of present sediment condition in the monitoring area and compare to 1999 survey.	Completed	June 2012
Evaluation of ZID Water Quality: Low-Flow Study (2)	Determine effects of lessened flow on plume concentration.	Completed	October 2012
Chlorination By-products (CBP) in Sediments and Fish Tissue	Determine concentrations of chlorination by-products.	Completed	June 2012
WET and Sediment Toxicity Studies	Review of historical and current whole effluent toxicity and whole sediment toxicity relative to observed benthic impacts.	Completed	June 2012
Ground Water Replenishment System Reverse Osmosis Reject Bioassay Study	Assess the biological and toxicological impacts of the Ground Water Replenishment System-Reverse Osmosis reject flows.	Completed	June 2012
Fish Liver Histopathology	Assess possible fish liver pathologies-disinfection by-product connection.	Completed	September 2012
Final Effluent Characterization	Comparison of final effluent prior/post disinfection and GWRS.	Completed	November 2012

review these studies and plant processes. They are expected to be empaneled in January 2014 and to make a recommendation for mitigation by the end of 2014.

SPECIAL STUDIES

J-112 – Ocean Modeling and Receiving Waters Monitoring for Standby Outfall Ocean Discharge

The District has two ocean outfalls located on the San Pedro shelf. Under normal operations, this discharge occurs through a 120-inch outfall that terminates in 60 meters of water, approximately 7 km offshore (henceforth denoted as the long outfall). From September 11 to October 2, 2012, infrastructure repairs and maintenance required the use of a shorter 78-inch outfall that terminates closer to shore (2.2 km) and in shallower water (18 m) (henceforth denoted as the short outfall); A monitoring and modeling plan was developed to track the discharged plume, measure the effectiveness of the enhanced disinfection program, and determine environmental effects to sediments and benthic infauna. This included effluent sampling, receiving water sampling, satellite imagery, and plume modeling. Participants included representatives of the Southern California Coastal Ocean Observing System (SCCOOS), including the University of Southern California and Scripps Institution of Oceanography.

<u>Summary/Findings</u>

Water Quality
Counts of total and fecal coliform and enterococci bacteria in the final effluent demonstrated the effectiveness of the enhanced disinfection process used for the diversion. Counts were predominantly below their respective AB411 geometric and single sample standards during the diversion until October 2, 2012, which was the initial target date for the end of the diversion. No trends or changes were seen in ammonium values.

Along the beach (e.g., Nearshore Waters), no temporal or spatial changes were seen in total coliform, fecal coliform or enterococci bacteria. Pre-diversion water quality surveys showed strong stratification (temperature and density) at stations beyond the 10 m contour. Salinity was generally uniform throughout the region with the exception of lower salinity seen at depth downcoast of the two OCSD outfalls; this is probably due to the discharge from the 120-inch ocean outfall. Additionally, during the September cruise, areas of lower salinity were seen at the surface at all of the upcoast stations. No elevated values ammonia or FIBs were observed while elevated levels of phytoplankton were observed at depth. In September, temperature and density gradients were seen at the 5-m stations. By October, stratification was seen primarily at the 20-m contour stations. Lower salinity and higher color dissolved organic matter (CDOM) waters were seen at the 78-inch outfall, rising to the surface and moving downcoast and offshore of the outfall (September 12-18). The plume was present directly inshore of the short outfall at the 10-m stations on September 24-25 followed by upcoast transport on October 1-2. During the diversion, no phytoplankton blooms were seen and, due to the enhanced effluent disinfection, few occurrences of elevated bacteria were seen.

The day after the diversion ended (October 3), no evidence of the plume discharged from the 78-inch outfall was seen in salinity, CDOM, ammonia, or bacteria. Subsequent surveys (October 9, 10, and 17) showed water quality changes associated with the 120-inch outfall.

Sediments and Infauna
The post-diversion sediment quality values were, for the most part, the same and/or lower than those of the pre-diversion samples at each sampling station, indicating essentially no outfall influence on sediment quality. Post-diversion biologic indices (e.g., Shannon-Wiener index [H′], Benthic Response Index [BRI], Infaunal Trophic Index [ITI] were generally higher than those of the pre-diversion samples, except the farfield upcoast stations. All post-diversion BRI scores were below 25 in the monitoring area indicating reference conditions. Infaunal Trophic Index (ITI) scores remained above 60 at the non-outfall stations, which is indicative of a normal infaunal community. Only the outfall station had a post-diversion ITI score of 50, indicating a changed biologic condition. This was likely due to the decrease in the change in the abundances of three polychaete species.

Overall, there were no significant changes in water or sediment quality as a result of discharge through the shortfall during the 3 week diversion. The enhanced effluent disinfection protected recreational uses in both the offshore and nearshore zones. While an increase in phytoplankton biomass occurred towards the end of the diversion, no blooms resulted, and pre-discharge conditions returned to the area within one day of the diversion ending. No ecologically significant differences were detected at the short outfall following the discharge event.

REGIONAL MONITORING

Regional Kelp Survey Consortium – Central Region

The Central Region Kelp Survey Consortium (CRKSC) was formed in 2003 to map giant kelp (*Macrocystis pyrifera*) beds off Ventura, Los Angeles, and Orange Counties via aerial photography. The program is modeled after the San Diego Regional Water Quality Control Board Region Nine Kelp Survey Consortium, which began in 1983. The CRKSC and San Diego aerial surveys provide synoptic coverage of kelp beds along approximately 220 of the 270 miles of the southern California mainland coast from northern Ventura County to the United States-Mexico Border. Survey results are published annually in a report provided by MBC Applied Environmental Sciences (2012). The District has been a member of the CRKSC program since 2003.

<u>2012 Results</u>
In the Central Region, the maximum measured kelp canopy increased from 4.427 square kilometers (km^2) in 2011 to 5.665 km^2 in 2012. The number of kelp beds displaying canopy remained markedly similar with the total number of beds monitored for the Central Region at 26 historic or existing kelp beds. The total amount of kelp present increased since the inception of the CRKSC program, peaking in 2009 with canopy coverage of 6.406 km^2, an amount greater than during any past CRKSC survey and of any past synoptic surveys (when all areas were surveyed) since 1989.

CRCSC 2012 results were slightly atypical, with most of the beds north of Point Dume reaching their greatest extent in June, while most of those from Point Dume and south to Laguna Beach reached their greatest extent reached in December. The exceptions in this range were the Palos Verdes I and Cabrillo kelp beds that were largest in April 2012. Throughout the entire study area, kelp canopy coverage increased but not uniformly, with distribution of kelp among the region's 26 kelp beds varying widely. The only kelp found in the District's monitoring area is the F&W Bed 12 that extends from Newport to south of Laguna Beach; this bed size has increased greatly, as the beds in that region continue to recover from the El Niños of the 1980s and 1990s.

The giant kelp surveys of 2012 continued to demonstrate that most kelp bed dynamics in the Central and San Diego regions are controlled by the large-scale oceanographic environment while micro-variations in local topography and currents can cause anomalies in kelp bed performances. There was no evidence of any adverse effects on the giant kelp resources from any of the region's dischargers.

REFERENCES

MBC Applied Environmental Sciences. 2013. Status of the Kelp Beds 2012 Survey. Prepared for the Central Region Kelp Survey Consortium. 60 pp. plus appendices.

OCSD. 2010. Annual Report, July 2008–June 2009. Marine Monitoring, Fountain Valley, California.

OCSD. 2011. Annual Report, July 2009–June 2010. Marine Monitoring, Fountain Valley, California.

OCSD. 2012. Annual Report, July 2010–June 2011. Marine Monitoring, Fountain Valley, California.

Smith, G.B. 1974. Some effects of sewage discharge to the marine environment. Ph.D. Dissertation. University of San Diego, CA. 334 pp.